Window expansion of the long-pulse small-ELM-dominant operation in EAST towards high-performance and low-collisionality regime

R. Chen¹, G.S. Xu¹, Q.Q. Yang¹, H.Q. Liu¹, S.Y. Ding¹, J.P. Qian¹, E.R. Li¹, S. Gu¹, Y.W. Sun¹, W.F. Guo¹, C. Zhou², A.D. Liu², Y. Liu¹, L. Zhang¹, Q. Zang¹, B. Lv¹, M. Xu¹, T.H. Shi¹, M.H. Li¹, Y.M. Duan¹, W. Gao¹, T. Zhang¹, B. Sheng¹, Y. Ye¹, L.M. Shao¹, L. Wang¹, M. Wang¹, Y.P. Zhao¹, F.K. Liu¹, C.D. Hu¹, B.N. Wan¹ and the EAST team

¹ Institute of Plasma Physics, Chinese Academy of Sciences, Hefei 230031, People's Republic of China
² CAS Laboratory of Geospace Environment, Department of Modern Physics, University of Science and Technology of China, Hefei 230026, People's Republic of China

Corresponding author: Name: Ran Chen Email: chenran@ipp.ac.cn

The previously-reported[1] long-pulse high-confinement plasma regime was recently demonstrated expandable to the operation window with significantly higher performance and lower pedestal collisionality in EAST, regardless of either pure Radio-Frequency (RF) heating scheme or Neutral Beam Injection (NBI) dominant one. However, due to a lack of large Edge-Localized Modes (ELMs), the concentration of high-Z impurities in the core region seems to be the most critical restriction of sustaining this operation regime, especially in the case with the employment of NBI with high input power. The effect of n=1 (n denotes the toroidal mode number) Resonant Magnetic Perturbation (RMP)[2], with varied poloidal spectrum by continuously scanning the phase difference between the upper and lower coil arrays, on the behaviour of ELMs was surveyed in a NBI-heating-dominant discharge. Corresponding observation shows that, involving some RMP spectrum with large plasma response, type-I ELMs with very low frequency and large amplitude were reproduced. On the contrary, the plasma operation retained to the original small-ELM-dominant regime as plasma response to the applied RMP was decreased, suggesting a relatively robust feature of this scenario. Finally, the termed Quasi-Coherent Mode (QCM, in some other previous article[3] of ours also named by Low-Frequency coherent Mode, shortened as LFM), which is an electromagnetic oscillation commonly observed in the small-ELM-dominant plasma regime, is also studied, presenting some similar characteristics of Alfven Eigenmode (AE). This work provides some foundations and references for the next-step research in EAST, aiming to achieve an ITER-relevant steady-state operation with high performance and tiny ELMs.